

CLAIM AMENDMENTS

1. (Original) A key actuation system for a keyboard instrument of the type having a plurality of keys, each key having an upper surface and a lower surface and being pivotally supported above a key bed, each key further having a front end that is depressed by a player to play a note, the key bed extending under and spaced from the lower surface of the key, the actuation system comprising:

an underlever disposed in the space between the lower surface of the key and the key bed and between the front end of the key and the pivotal support, the underlever having a first end that is supported in a stationary position relative to the key bed, a second end that is movable towards and away from the key bed, and a midportion therebetween, the second end of the underlever being in mechanical communication with the key such that movement of the second end of the underlever towards the key bed causes the key to move as if depressed by a player;

an actuator in mechanical communication with the underlever and operable to move the second end of the underlever towards the key bed.

2. (Currently Amended) The key actuation system according to claim 1, wherein the actuator comprises a pull solenoid having a coil portion and a piston, the solenoid operative when the coil portion is energized to draw the piston into the coil portion, the solenoid mounted such that the coil portion is disposed below the midportion of the underlever, the piston being in mechanical communication with the midportion of the underlever such that when the coil portion of the solenoid is energized, the piston pulls the midportion of the underlever downwardly causing the second end of the underlever to move towards the key bed. -

3. (Currently Amended) The key actuation system according to claim 1, wherein the actuator comprises a push solenoid having a coil portion and a piston, the solenoid operative when the coil portion is energized to push the piston out of the coil portion, the solenoid mounted such that the coil portion is disposed above the midportion of the underlever, the piston being in mechanical communication with the midportion of the underlever such that when the coil portion of the solenoid is energized, the piston pushes the midportion of the underlever downwardly causing the second end of the underlever to move towards the key bed. -

4. (Currently Amended) The key actuation system according to claim 1, wherein the underlever is a flexible underlever that flexes when the actuator moves the underlever. -

5. (Currently Amended) An actuation system for a keyboard instrument of the type having a plurality of pivotally supported keys having front ends that are depressed by a player to play a note, the keyboard instrument further having a counterweight system comprising a counterweight that is supported separate from the keys, the counterweight being in mechanical communication with one of the keys such that depression of the front end of the key causes the counterweight to move in a first direction, the actuation system comprising:

an actuator operable to move the counterweight in the first direction. -

6. (Currently Amended) The actuator system according to claim 5, wherein the counterweight is pivotally supported and pivots when the key is depressed, the first direction being a rotational direction and the actuator being operable to pivot the counterweight in the first rotational direction. -

7. (Currently Amended) ~~The actuator system according to claim 5, wherein~~ An actuation system for a keyboard instrument of the type having a plurality of pivotally supported keys having front ends that are depressed by a player to play a note, the keyboard instrument further having a counterweight system comprising a counterweight that is in mechanical communication with one of the keys such that depression of the front end of the key causes the counterweight to move in a first direction, the actuation system comprising:

an actuator operable to move the counterweight in the first direction, the actuator is being a push solenoid having a coil portion and a piston, the actuator operable when the coil portion is energized to push the piston at least partially out of the coil portion, the solenoid being mounted such that the piston is in mechanical communication with part of the counterweight and is operable to push on the part of the counterweight when the coil portion is energized to cause the counterweight to move in the first direction. -

8. (Currently Amended) ~~The actuator system according to claim 5, wherein~~ An actuation system for a keyboard instrument of the type having a plurality of pivotally supported keys having front ends that are depressed by a player to play a note, the keyboard instrument further having a counterweight system comprising a counterweight that is in mechanical communication with one of the keys such that depression of the front end of the key causes the counterweight to move in a first direction, the actuation system comprising:

an actuator operable to move the counterweight in the first direction, the actuator is being a pull solenoid having a coil portion and a piston, the actuator operable when the coil portion is energized to draw the piston into the coil portion, the solenoid being mounted such that the piston is

in mechanical communication with part of the counterweight and is operable to pull on the part of the counterweight when the coil portion is energized to cause the counterweight to move in the first direction. -

9. (Currently Amended) ~~The actuator system according to claim 5, wherein~~ An actuation system for a keyboard instrument of the type having a plurality of pivotally supported keys having front ends that are depressed by a player to play a note, the keyboard instrument further having a counterweight system comprising a counterweight that is in mechanical communication with one of the keys such that depression of the front end of the key causes the counterweight to move in a first direction, the actuation system comprising:

an actuator operable to move the counterweight in the first direction, a portion of the counterweight ~~comprising~~ comprising a ferromagnetic material and the actuator ~~is being~~ operable to electromechanically move the ferromagnetic material to cause the counterweight to move in the first direction. -

10. (Currently Amended) A player keyboard instrument for producing notes and actuating the keys to simulate being played by an operator, the keyboard instrument comprising:

a key bed;

a plurality of keys, each key having an upper surface and a lower surface and being pivotally supported above the key bed, each key further having a front end that is depressed by a player to play a note, the key bed extending under and spaced from the lower surface of the key, each key having a post extending downwardly from the lower surface of the key towards the key bed, the post including a portion of ferromagnetic material;

a counterweight system comprising a plurality of counterweights, one of the counterweights being in mechanical communication with each of the keys such that depression of the front end of each key causes the corresponding counterweight to move in a first direction;

a plurality of actuator coils disposed in the space between the lower surface of the keys and the key bed, one of the actuator coils being disposed about each of the posts, each actuator coil operable to electromechanically move the ferromagnetic portion of the corresponding post downwardly so as to move the corresponding key. -

11. (Currently Amended) A key actuation system for a keyboard instrument of the type having a plurality of keys, each key being pivotally supported and having a front end that is depressed by a player to play a note, the actuation system comprising:

a plurality of actuators operable to move at least some of the plurality of keys, the plurality of actuators together comprising:

a block of ferromagnetic material with a plurality of bores defined therein,

a winding disposed in each of the bores, each of the windings having a hole defined therein, and

a piston at least partially disposed in each of the holes, each piston being in mechanical communication with one of the keys such that movement of the piston causes movement of the key;

wherein energizing one of the windings causes the corresponding piston to move relative to the winding, thereby moving one of the keys. -

12. (Currently Amended) The key actuation system according to claim 11, wherein each of the keys further has a rear end that moves upwardly when the front end is depressed, the actuation system further comprising a plurality of underlevers each having a movable end and a mounted end, the movable end being positioned under the rear end of one of the keys such that upward movement of the movable end causes the movable end to lift the rear end of the key upwardly, the underlevers providing the mechanical communication between the pistons and the keys. -

13. (Currently Amended) The key actuation system according to claim 12, wherein the block is positioned rearwardly of the rear ends of the keys and the underlevers are disposed above the block, the plurality of actuators being push solenoids such that energizing the windings causes the pistons to move upwardly out of the holes in the windings and push on the underlevers. -

14. (Currently Amended) The key actuation system according to claim 12, wherein the block is positioned rearwardly of the rear ends of the keys and the underlevers are disposed below the block, the plurality of actuators being pull solenoids such that energizing the windings causes the pistons to be drawn upwardly into the holes in the windings and to pull on the underlevers. -

15. (Currently Amended) The key actuation system according to claim 11, further comprising a plurality of underlevers each having a movable end and a mounted end, the movable end being positioned under the one of the keys between the front end of the key and the pivotal support, the movable end being in mechanical communication with the key such that downward

movement of the movable end causes the front end of the key to be moved downwardly, the underlevers providing the mechanical communication between the pistons and the keys. -

16. (Currently Amended) The key actuation system according to claim 15, wherein the block is positioned below the underlevers, the plurality of actuators being pull solenoids such that energizing the windings causes the pistons to be drawn downwardly into the holes in the windings and to pull down on the underlevers. -

17. (Currently Amended) The key actuation system according to claim 15, wherein the block is positioned below the keys and above the underlevers, the plurality of actuators being push solenoids such that energizing the windings causes the pistons to move downwardly out of the holes in the windings and to push down on the underlevers. -

18. (Currently Amended) A key actuation system for a keyboard instrument of the type having a key fulcrum pivotally supporting a plurality of keys, each key having a front end disposed forward of the fulcrum which is depressed by a player, and a rear end disposed rearward of the fulcrum that pivots upwardly when the front end is depressed, said system comprising:

a pivotal support;

a rocking lever arm supported by the support and having a lifting end on one side of the support in mechanical communication with the rear end of one of the keys and a piston end on the other side of the support, the piston end including a portion of ferromagnetic material; and

an actuator coil having a opening therein, the coil disposed such that the piston end of the lever arm is at least partially disposed in the opening, the actuator operable to electromechanically move the piston end of the lever arm. -

19. (Currently Amended) The actuation system according to claim 18, wherein the piston end of the rocking lever arm is generally blade shaped and the coil is generally rectangular with a generally rectangular opening therein. -

20. (Currently Amended) The actuation system according to claim 18, wherein the pivotal support is disposed rearward of the rear end of the key and the piston end of the lever arm is positioned rearward of the pivotal support. -

21. (Currently Amended) A key actuation system for a keyboard instrument of the type having a plurality of pivotally supported keys each having a front end which is to be depressed by a player to pivot the key, said system comprising:

a primary underlever having a mounted end and a free end that is movable in at least a first direction;

an actuator operable to move the primary underlever such that the free end of the primary underlever moves in the first direction; and

a secondary underlever having a mounted end and a free end that is movable in at least a second direction, the free end being in mechanical communication with one of the keys such that when the free end of the secondary underlever moves in the second direction, the key pivots as if



depressed by a player, the secondary underlever further having a midportion defined between the mounted and free ends;

the free end of the primary underlever being in mechanical communication with the midportion of the secondary underlever such that when the free end of the primary underlever moves in the first direction, the free end of the secondary underlever is moved in the second direction. -

22. (Currently Amended) A player keyboard instrument for producing notes and actuating the keys to simulate being played by an operator, the keyboard instrument comprising:

a plurality of pivotally supported keys, each key having an upper surface and a lower surface, each key further having a front end that is depressed by a player to play a note, each key having a post extending downwardly from the lower surface of the key, the post including a portion of ferromagnetic material;

a sensor operable to sense movement of the posts of each of the keys;

a sound reproduction system in communication with the sensor and operable to produce sound in response to movement of the posts; and

a plurality of actuator coils, one of the actuator coils being disposed about each of the posts, each actuator coil operable to electromechanically move the corresponding post downwardly so as to move the corresponding key. -

23. (Currently Amended) The keyboard instrument according to claim 22, wherein the sensor comprises a plurality of individual sensors. -

24. (Original) The keyboard instrument according to claim 22, wherein each of the posts includes a finger extending from a lower end thereof, the sensor being operable to sense movement of fingers.

25. (New) The actuator system according to claim 5, wherein the actuator is a push solenoid having a coil portion and a piston, the actuator operable when the coil portion is energized to push the piston at least partially out of the coil portion, the solenoid being mounted such that the piston is in mechanical communication with part of the counterweight and is operable to push on the part of the counterweight when the coil portion is energized to cause the counterweight to move in the first direction.

26. (New) The actuator system according to claim 5, wherein the actuator is a pull solenoid having a coil portion and a piston, the actuator operable when the coil portion is energized to draw the piston into the coil portion, the solenoid being mounted such that the piston is in mechanical communication with part of the counterweight and is operable to pull on the part of the counterweight when the coil portion is energized to cause the counterweight to move in the first direction.

27. (New) The actuator system according to claim 5, wherein a portion of the counterweight comprises a ferromagnetic material and the actuator is operable to electromechanically move the ferromagnetic material to cause the counterweight to move in the first direction.